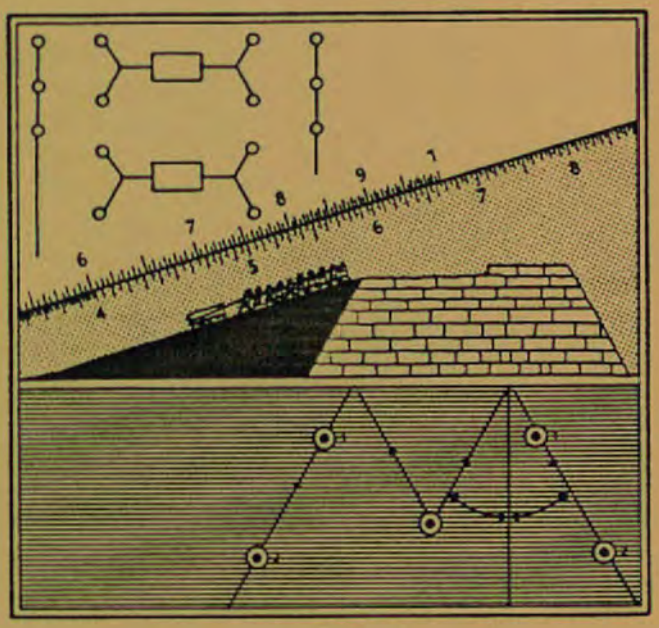
Student Achievement Testing Program Bulletin

Grade 9 Science



1988-89 School Year

Alberta
EDUCATION
Student Evaluation and Records
September 1988

This bulletin contains general information about the 1989 Student Achievement Testing Program, and information specific to the Grade 9 Science Achievement Test. Additional copies of this bulletin may be obtained by telephoning Alberta Education at 427-2948.

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INTRODUCTION

Purpose of the Bulletin

The Grade 9 Science Achievement Test will be written on June 13, 1989. This bulletin provides specific information about the design, the composition, and the scoring of the Grade 9 Science Achievement Test.

Teachers should also refer to the publication *Grade 9 Science Curriculum Specifications (1986)*, which presents the specific content and objectives that guide the development of the test questions.

Students should have access to the information in this bulletin, particularly to the sample questions.

Questions or comments regarding this bulletin should be directed to:

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Purpose of the Achievement Testing Program

The Achievement Testing Program provides Alberta Education, school jurisdictions, and the public with information significant at the provincial and local levels about student knowledge, understanding, and skills in relation to program objectives. This program is not intended to provide information to be used for student placement or promotion.

The achievement tests are administered on a four-year cycle in four subject areas: Language Arts, Social Studies, Mathematics, and Science; and at three grade levels: 3, 6, and 9.

Nature of the Achievement Testing Program

The achievement tests are specific to the program of studies prescribed by the Minister of Education. Curriculum specifications for each subject area, provided by the Curriculum Branch and the Language Services Branch of Alberta Education, identify the major content areas, the specific learning objectives within each content area, and the emphasis that each objective is to receive. The test questions reflect these curriculum specifications.

Classroom teachers from across the province are extensively involved in developing and field testing the questions. The student responses are analysed after field testing to determine each question's suitability for inclusion on a test. Questions may undergo several revisions before they appear on the achievement test.

The final draft of each test is examined by an Achievement Test Review Committee that includes representatives of The Alberta Teachers' Association, the Conference of Alberta School Superintendents, Alberta's post-secondary institutions, and Alberta Education.

Exemptions from the Achievement Testing Program

The results of the Achievement Testing Program are significant at the school jurisdiction level. All students who have been taught the subject being tested are expected to participate in the Achievement Testing Program. Any exceptions must be identified by the principal and approved by the superintendent of schools.

The only students who may be excused from participating are those for whom the test is inappropriate. That is:

1. Students who are enrolled in an approved program that has been designed for special needs students
2. Students who were taught the subject being tested in another semester or year
3. Students who are enrolled in an English as a Second Language program
4. Students who are being taught the specific subject being tested (mathematics, science, or social studies) in a language other than English

Exemptions for reasons other than those outlined must be approved by the Director of the Student Evaluation and Records Branch.

Students Receiving Instruction in French

French translations of the Social Studies and Science achievement tests are available for grades 6 and 9 according to the schedule on page 4. School jurisdictions that intend to have their students write achievement tests in French must notify Alberta Education prior to March 1, 1989.

Administration of the Achievement Testing Program

The Achievement Testing Program is administered in accordance with directives issued by the Director, Student Evaluation and Records Branch under the authority of the *Evaluation of Students Regulations*. The achievement tests must be administered on the scheduled dates and may not be rescheduled.

The achievement tests must remain unopened until the time of writing. Duplication of any test materials, including the test booklets and answer sheets, is expressly forbidden.

Immediately following the administration of the scheduled achievement tests, the principal must ensure that test booklets and answer sheets are forwarded to school board offices. The school board is responsible for collecting and forwarding to the Student Evaluation and Records Branch all test materials containing students' responses. Further details regarding procedures for returning these materials to the Branch will be issued when the achievement tests are delivered. For private schools, the Regional Offices of Alberta Education assume responsibility for collecting and forwarding test materials to the Student Evaluation and Records Branch. All unused testing materials may be retained by the school jurisdiction.

Alberta Education will supervise the scoring of all achievement tests. The scoring of achievement tests by school personnel prior to returning test materials to the Student Evaluation and Records Branch is a violation of the *Examination Rules* and contrary to the intent of the Achievement Testing Program.

In 1989, the achievement tests will be administered according to the following schedule:

Tuesday, June 13, 1989 (Morning)

Grade 3 English Language Arts

Grade 6 Social Studies*

Grade 9 Science*

In 1990, the achievement tests will be administered according to the following schedule:

Tuesday, June 12, 1990

Grade 3 Mathematics

Grade 6 Science*

Grade 9 English Language Arts

Thursday, June 14, 1990

Grade 9 French Language Arts

* A French translation of this test is available. The French translation must be administered at the same time as the English version.

Reporting the Achievement Test Results

In September 1989, a provincial report will be issued that will present the overall results for the province on major curriculum dimensions. Each jurisdiction will receive a district profile of student achievement to parallel the provincial report, as well as guidelines for interpreting the jurisdictional results in relation to provincial norms. Alberta Education will not issue individual statements of results to students; individual student profiles will be sent to superintendents and to the principals of the schools where the students wrote the test.

Consistent with our current interim French Student Evaluation Policy, provincial reports will not be prepared for the French translations of the achievement tests in Grade 6 Social Studies or Grade 9 Science.

Jurisdictions that choose to have their Francophone and/or French Immersion students write a French translation of the achievement tests in Grade 6 Social Studies or Grade 9 Science will receive reports of jurisdiction and school results. Until the amount of time devoted to instruction in French is relatively uniform across the province, permitting valid and reliable interpretation of provincial data, provincial reports of achievement tests in French language programs will not be prepared.

DESCRIPTION OF THE GRADE 9 SCIENCE ACHIEVEMENT TEST

General Description

The time allotted for writing the Grade 9 Science Achievement Test is one and one-half hours.

The test consists of 75 multiple-choice questions that are answered on machine-scorable answer sheets.

Students must use HB pencils and erasers. Calculators are not required for successful completion of the test. However, any student who wishes to use a calculator may do so.

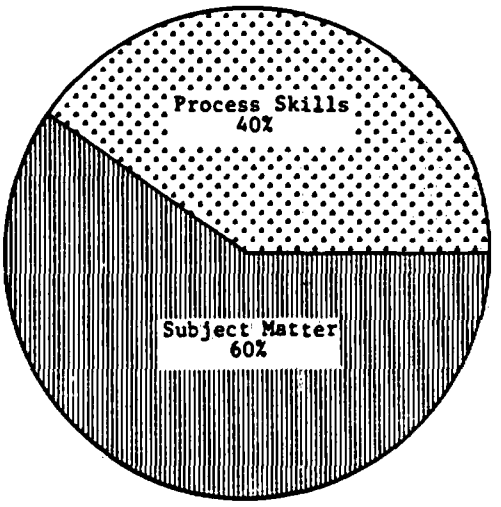
Content of the Test

The four major components of the Grade 9 Science curriculum and the emphasis that each is to receive according to the *Grade 9 Science Curriculum Specifications* (July 1981) form the basis for the achievement test. These are:

Component	Emphasis
Process Skills	30%
Psychomotor Skills	10%
Attitudes	10%
Subject Matter	50%

The scope of the Grade 9 Science Achievement Test is, of course, limited to those objectives that may be efficiently tested using paper and pencil. While some questions on the test may reflect the psychomotor skills component, basically it is the process skills and subject matter components of the curriculum that are tested. The psychomotor skills and attitudinal components will be reflected in the teacher's evaluation of students.

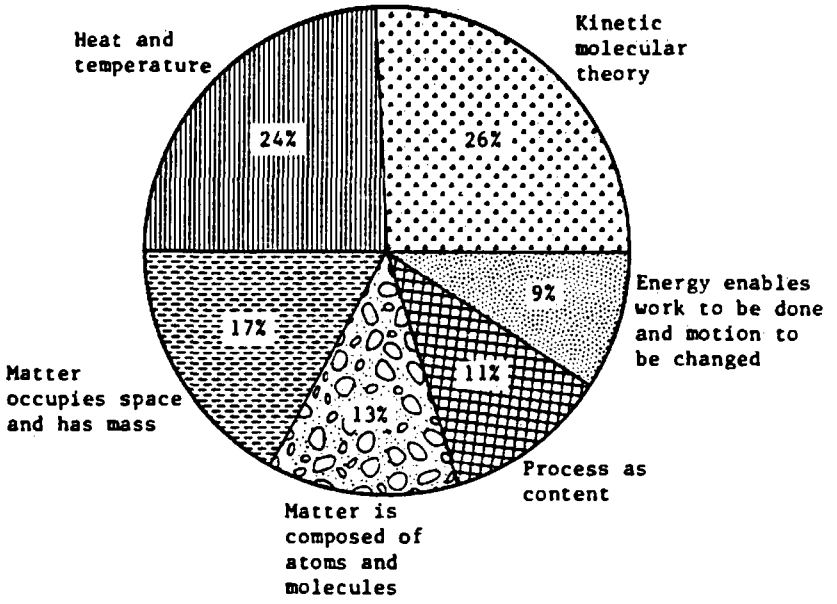
The emphasis given to the process skills and subject matter components is shown in the circle graph below.



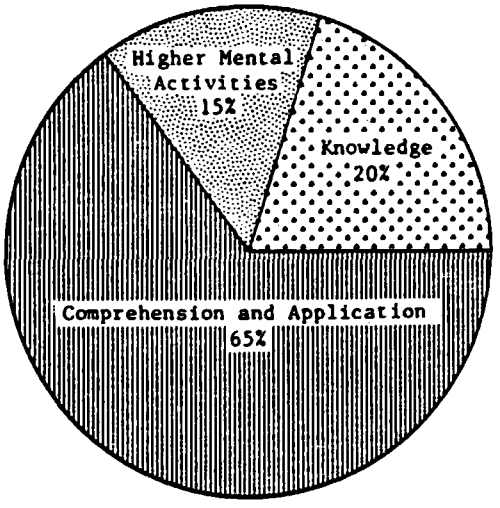
The subject matter component is divided into five subtests to reflect the subdivisions in the Grade 9 Science core. These subdivisions are listed below.

9.1 Matter Occupies Space and Has Mass
9.2 Kinetic Molecular Theory
9.3 Heat and Temperature
9.4 Energy Enables Work to be Done and Motion to be Changed
9.5 Matter is Composed of Atoms and Molecules

The process skills component is divided into two parts: process integrated with subject matter and process as content. Questions based on the latter comprise the sixth subtest. A detailed description of the process skills framework is included in Appendix A. The emphasis given to each subtest is shown in the circle graph below.



The test questions represent three cognitive levels of knowledge, comprehension and application, and higher mental activities. An explanation of these terms is given in Appendix B. The emphasis given to each cognitive level is shown in the circle graph below.



Blueprint for the Achievement Test

The per cent emphasis for each subtest, cognitive level, and component are presented in the table below.

Table 1: Grade 9 Science - Test Blueprint in Per Cent Emphasis

SUBTEST[1]	COGNITIVE LEVELS[2]			TOTAL	COMPONENT		TOTAL
	*K	*C/A	*HMA		Process[3] Skills	Subject Matter	
Matter Occupies Space	4	11	2	17	6	11	17
Kinetic Molecular Theory	5	17	4	26	8	18	26
Heat and Temperature	5	15	4	24	8	16	24
Energy	2	6	2	10	3	7	10
Atoms and Molecules	1	9	2	12	4	8	12
Process Skills as Content	3	7	1	11	11	-	11
Total	20	65	15	100	40	60	100

[1] Subtest descriptions have been shortened in this table

[2] Refer to Appendix B

[3] This column indicates the percentage of test questions in which process skills are integrated with subject matter.

*K Knowledge
*C/A Comprehension and Application
*HMA Higher Mental Activities

Sample Questions

Questions that reflect the nature and complexity of the questions that will appear on the achievement test are presented on the following pages.

Teachers are encouraged to familiarize their students with the type of questions and the process skills vocabulary that will appear on the achievement test by having their students work through the sample questions. The difficulty level of the question indicates the percentage of students who answered the question correctly in the previous achievement test.

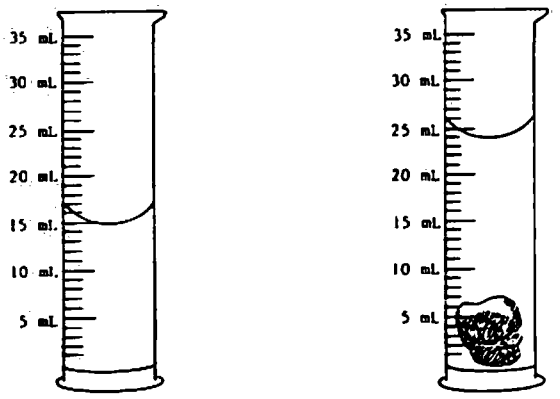
Please note that this collection of 12 questions roughly approximates the test emphasis as presented in the blueprint.

An asterisk denotes the correct answer for each sample question.

Question 1
Concept: 9.1.2 (b) Matter Occupies Space and Has Mass [Matter can be measured by determining its linear dimensions, surface area, and volume (b) The volume of irregular shaped solids may be found indirectly by liquid displacement.]
Cognitive Level: Comprehension and Application
Process Skill: Gathering Data
Difficulty Level: 0.836

Use the following to answer question 1.

The volume of a solid is found using the procedure illustrated.



1. The volume of the solid is

* A. 9 mL
B. 15 mL
C. 24 mL
D. 26 mL

In this question the student is required to apply the process skill of *Gathering Data* by using a measuring instrument to determine the volume of an irregular solid by liquid displacement.

Question 2
Concept: 9.2.1 (c) Kinetic Molecular Theory [Matter is composed of tiny particles. (c) Spaces exist between the molecules of matter.]
Cognitive Level: Comprehension and Application
Difficulty Level: 0.741

2. Gases are much more easily compressed than are liquids or solids. The most acceptable explanation for this observation is that

   A. gas molecules are perfectly elastic, and elastic substances are easily compressed

   B. gas molecules move at much greater velocities than do the molecules of liquids and solids

   * C. the average distance between molecules in gases is much greater than that between molecules in liquids and solids

   D. the attractive forces between molecules in solids and liquids are much smaller than those between molecules in gases

   In this question the student is required to apply knowledge related to spaces existing between molecules of matter.

Question 3
Concept: 9.2.2 (b, c) Kinetic Molecular Theory [Molecules are in a state of constant motion. (b) Molecular motion in solids may be vibrational about a fixed position. (c) Molecules in liquids may be able to slide or move over one another in random directions.]
Cognitive Level: Comprehension and Application
Difficulty Level: 0.673

3. When molecules that originally vibrate about a fixed position start to slide over one another in random directions, matter changes from a

   A. liquid into a gas
   B. gas into a liquid
   * C. solid into a liquid
   D. liquid into a solid

   In this question the student is required to apply knowledge related to molecular motion in solids and liquids.

Question 4
Concept: 9.2.3 Kinetic Molecular Theory [Molecular movement is the basis for diffusion.]
Cognitive Level: Knowledge
Difficulty Level: 0.592

4. The motion of molecules within a gas causes

   * A. diffusion
   B. sublimation
   C. evaporation
   D. condensation

   In this question the student is required to recall knowledge related to diffusion in gases.

Question 5
Concept: 9.2.4 (d) Kinetic Molecular Theory [Molecular motion results in evaporation. (d) Different liquids evaporate at different rates.]
Cognitive Level: Higher Mental Activities
Process Skill: Questioning
Difficulty Level: 0.597

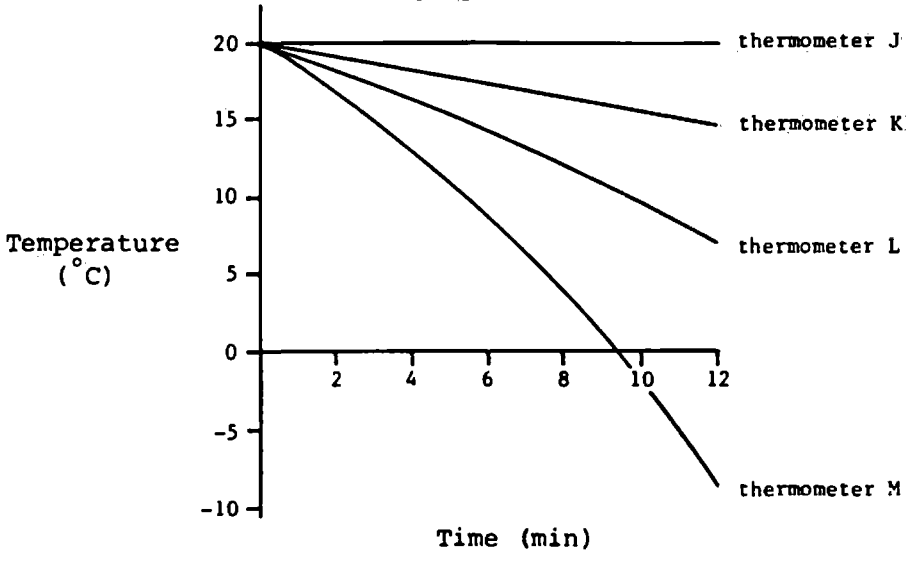
Use the following information to answer question 5.

Four thermometer bulbs were each wrapped in a layer of cotton cloth and placed into separate beakers for two minutes.

Thermometer J was placed into a beaker containing air. Thermometer K was placed into a beaker containing liquid K. Thermometer L was placed into a beaker containing liquid L. Thermometer M was placed into a beaker containing liquid M.

After the thermometers were removed from the beakers, the temperature for each thermometer was recorded every minute for 12 minutes.

The results are shown on the graph.



5. What is the problem that was being investigated in this experiment?

A. What effect does the type of cloth have on the rate of evaporation?
* B. What effect does the type of liquid have on the rate of evaporation?
C. What effect does the air temperature have on the rate of evaporation?
D. What effect does the quantity of liquid have on the rate of evaporation?

In this question the student is required to select the best problem statement by using the process skills of *Questioning* to determine the specific variables being studied and to apply the knowledge related to evaporation.

Question 6
Concept: 9.3.1 (a) Heat and Temperature [Heat and temperature are related. (a) Temperatures may be measured indirectly by utilizing the response of matter to changes in temperature. Several temperature scales have been devised (Celsius, Kelvin, and others).]
Cognitive Level: Knowledge
Difficulty Level: 0.667

6. Absolute zero is defined as the temperature at which

* A. all molecular motion ceases
B. pure oxygen turns to a solid
C. the temperature reading is 0°C
D. pure hydrogen turns to a liquid

In this question the student is required to recall knowledge related to the Kelvin temperature scale.

Question 7
Concept: 9.3.1 (b) Heat and Temperature [Heat and temperature are related. (b) Heat is measured indirectly by the effects it produces: heat is measured by observing the change in temperature of a known mass of water at a known initial temperature.]
Cognitive Level: Comprehension and Application
Difficulty Level: 0.688

7. How much heat energy is required to raise the temperature of 100 g of water from 15°C to 30°C? Note: Specific heat of water = 4200 J/kg•°C.

A. 21 J
B. 1500 J
* C. 6300 J
D. 26 460 J

In this question the student is required to apply knowledge related to the measurement of heat by determining the temperature change of a known mass of water at a known initial temperature.

Question 8
Concept: 9.3.2 Heat and Temperature [Matter exists in different states.]
Cognitive Level: Comprehension and Application
Process Skill: Interpreting Data
Difficulty Level: 0.545

8. The boiling point of a substance is 12°C and its melting point is -40°C. At -15°C the substance will be a

   A. gas
   B. solid
   C. vapor
   * D. liquid

   In this question the student is required to apply knowledge related to the three states of matter by using the process skill of *Interpreting Data*.

Question 9
Concept: 9.3.3 Heat and Temperature [A relationship exists between molecular motion and the volume occupied by matter.]
Cognitive Level: Higher Mental Activities
Difficulty Level: 0.373

9. A weather balloon increases in volume as it ascends to higher altitudes. In terms of the kinetic molecular theory, the expansion of the balloon is due to

   A. an increase in the average kinetic energy of the atmospheric particles

   B. a decrease in the average kinetic energy of the particles inside the balloon

   * C. a decrease in the rate of collisions of atmospheric particles against the outside walls of the balloon

   D. an increase in the rate of collisions of atmospheric particles against the outside walls of the balloon

   In this question the student is required to apply knowledge related to molecular motion and the volume occupied by matter.

Question 10
Concept: 9.4.3 Energy [One form of energy may be changed into another.]
Cognitive Level: Comprehension and Application
Process Skill: Interpreting Data
Difficulty Level: 0.578

Use the following information to answer question 10.

1000 J of electricity were used to work each of four electrical appliances. The energy output was measured and is given in the following table.

Appliance	Energy Input	Energy Output
Electric saw	1000 J electrical energy	500 J mechanical energy 150 J heat energy 350 J sound energy
Vacuum cleaner	1000 J electrical energy	650 J mechanical energy 150 J heat energy 200 J sound energy
Electric mixer	1000 J electrical energy	750 J mechanical energy 120 J heat energy 130 J sound energy
Electric drill	1000 J electrical energy	450 J mechanical energy 250 J heat energy 300 J sound energy

10. What reduces the efficiency of the electric saw?

A. Only heat energy
* B. Heat and sound energy
C. Mechanical and heat energy
D. Sound and mechanical energy

In this question the student is required to apply knowledge related to one form of energy being changed to another by using the process skill of *Interpreting Data*.

Question 11
Concept: 9.5.2 Atoms and Molecules [A relationship exists between atoms and molecules: atoms can exist individually or in combination with other atoms of the same or different elements, and therefore, are the building blocks of molecules.]
Cognitive Level: Comprehension and Application
Difficulty Level: 0.571

11. A molecule of water (H_2O) is made up of two different kinds of atoms,

A. two elements, and a total of two atoms
B. two compounds, and a total of two atoms
* C. two elements, and a total of three atoms
D. two compounds, and a total of three atoms

In this question the student is required to apply the knowledge related to the relationship between atoms, elements, and compounds.

Question 12
Cognitive Level: Higher Mental Activities
Process Skill: Designing Experiments
Difficulty Level: 0.649

Use the following information to answer question 12.

A Grade 9 Science class listed the variables that they thought might affect the time required to melt an ice cube. The list included:

mass of the ice cube
temperature of the room
shape of the ice cube

One student decided to test the hypothesis that the shape of an ice cube affects the time required to melt the ice cube.

12. Which design should the student select to test this hypothesis?

A. Use five ice cubes, each with a different shape and mass. Use five identical containers, all at the same temperature. Observe the melting time of the ice cubes.

B. Use five ice cubes, all having the same shape, but each having a different mass. Use five identical containers, all at the same temperature. Observe the melting time of the ice cubes.

* C. Use five ice cubes, all having the same mass, but each having a different shape. Use five identical containers, all at the same temperature. Observe the melting time of the ice cubes.

D. Use five ice cubes, all having the same mass, but each having a different shape. Use five identical containers, each at a different temperature. Observe the melting time of the ice cubes.

In this question the student is required to use the process skill of *Designing Experiments* by evaluating experimental designs and then select the best design to test a given hypothesis.

APPENDIX A: PROCESS SKILLS

Process Skills Framework

Instruction toward the development of the process skills and general understanding of scientific inquiry should include the following outcomes.

1. *QUESTIONING*

    1.1 Formulating and Expressing Relevant Questions

        1.1.1 Perceive discrepant events relative to subject matter studies.

        1.1.2 Perceive possible relationships between objects, events, properties, and/or living things.

        1.1.3 Express questions about perceived relationships.

    1.2 Defining Problem Statements

        1.2.1 Identify specific variables for study.

        1.2.2 State possible relationships between these variables.

        1.2.3 Distinguish information that is relevant to the problem statement from information that is irrelevant.

    1.3 Recognizing Limitations to Scientific Investigation of Given Questions or Problems

        1.3.1 Recognize assumptions and limitations implied in the phrasing of questions or problem statements.

        1.3.2 Recognize the limitations of empirical methods as a means of answering identified questions.

2. *PROPOSING IDEAS*

    2.1 Formulating Hypotheses

        2.1.1 Describe proposed relationships between variables, referring to known models, theories, and other background information where possible.

        2.1.2 Describe possible relationships between variables in quantitative terms where applicable.

        2.1.3 Evaluate hypotheses based on existing knowledge and experience.

    2.2 Stating Predictions

        2.2.1 Predict occurrences and events.

2.2.2 Make predictions based on interpolation or extrapolation.

2.2.3 Make predictions based on the application of a mathematical formula.

3. *DESIGNING EXPERIMENTS*

3.1 Defining Operationally

3.1.1 Construct operational definitions.

3.1.2 Distinguish between operational and nonoperational definitions.

3.2 Identifying and Controlling Variables

3.2.1 Identify manipulated (independent) and responding (dependent) variables.

3.2.2 Identify variables to be controlled and devise means for controlling them.

3.3 Determining Procedures

3.3.1 Select techniques that are appropriate to the problem and that are safe and ethically sound.

3.3.2 Select suitable apparatus.

3.3.3 Identify the purpose of each procedure.

3.3.4 Determine an appropriate sequence for procedures.

3.3.5 State procedures clearly.

3.3.6 Design a suitable format for recording data.

3.3.7 Determine the headings to be used within the data recording format.

3.3.8 Choose appropriate intervals for the manipulated variable.

3.3.9 Determine the sample size.

3.3.10 Determine an appropriate number of trials to give reasonable reliability.

3.3.11 Determine reasonable levels of precision for all measures.

3.4 Evaluating Experimental Designs and Suggesting Modifications Where Appropriate

3.4.1 Identify variables that are not controlled by the procedures to be used.

3.4.2 Identify possible sources of procedural or measurement error.

3.4.3 Suggest methods for improving the precision of measures used.

3.4.4 Identify missing or extraneous steps in an experimental design.

3.4.5 Adjust experimental procedures.

4. *GATHERING DATA*

4.1 Observing Accurately

4.1.1 Distinguish between observations and inferences.

4.1.2 Use specialized observation equipment effectively.

4.1.3 Use specified sampling and manipulative equipment effectively.

4.2 Measuring Accurately

4.2.1 Identify the precision of measuring instruments used.

4.2.2 Use measuring instruments with skill and precision.

4.2.3 Repeat observations and measurements where questionable data arise.

4.3 Recording Data Clearly and Completely

4.3.1 Record descriptive observations accurately.

4.3.2 Record measurements in a form that expresses the precision of instruments used.

4.3.3 Prepare labelled diagrams of objects and materials studied.

4.4 Estimating Quantities and Measures

4.4.1 Estimate quantity of objects observed.

4.4.2 Estimate measures of objects or events observed.

4.4.3 Distinguish between reasonable and unreasonable values for direct and derived measurements.

5. *PROCESSING DATA*

5.1 Organizing and Presenting Data

5.1.1 Classify data into appropriate categories.

5.1.2 Design charts or tables for processed data.

5.1.3 Select and apply suitable mathematical treatments of data.

5.1.4 Indicate units throughout all calculations.

5.1.5 Produce suitable graphs.

5.1.6 Choose other means of presenting data where appropriate.

5.2 Determining Patterns and Trends in Data

5.2.1 Identify patterns and trends.

5.2.2 Produce "best fit" lines for graphs.

5.2.3 Identify anomalies in data.

5.3 Determining Experimental Error Both for Original Data and for Values Derived from these Data

5.3.1 Use significant digits in expressing experimental results.

5.3.2 Calculate the per cent error of experimentally determined values (relative to accepted or predicted values).

6. *INTERPRETING DATA*

6.1 Identifying Limits to Interpretations

6.1.1 State limitations affecting interpretation of the data.

6.1.2 Use language that expresses an appropriate level of certainty/uncertainty in stating interpretations.

6.2 Generating Appropriate Explanations, Theories, and/or Models

6.2.1 Draw inferences from data.

6.2.2 State interpretations within the limits of the experimental design.

6.2.3 Revise hypotheses in accordance with data collected.

6.2.4 Generate appropriate explanations, models, and/or theories.

6.2.5 Evaluate alternative explanations, models, and/or theories.

6.3 Generating Ideas for Extending Knowledge Related to the Area of Investigation

6.3.1 Determine the need for an extension of the investigation.

6.3.2 Identify additional questions to investigate.

APPENDIX B: EXPLANATION OF COGNITIVE LEVELS

1. Knowledge

   Knowledge is defined as those behaviors and test situations that emphasize the remembrance, either by recognition or recall, of ideas, material, or phenomena. This level comprises knowledge of terminology, specific facts (dates, events, persons, etc.), conventions, classifications and categories, methods of inquiry, principles and generalizations, and theories and structures.

2. Comprehension and Application

   Application requires that the students apply an appropriate abstraction (theory, principle, idea, and/or method) to a new situation.

   Comprehension refers to responses that demonstrate understanding of the literal message contained in a communication. This means that the student is able to translate, interpret, or extrapolate. Translation refers to the ability to put a communication into another language. Interpretation involves the reordering of ideas (inferences, generalizations, or summaries). Extrapolation is the ability to make estimates or predictions based on an understanding of trends or tendencies.

3. Higher Mental Activities

   Analysis, synthesis, and evaluation are included in the category of higher mental activities. Analysis comprises the ability to recognize unstated assumptions, to distinguish facts from hypotheses, to distinguish a conclusion from statements that support it, to recognize facts or assumptions that are essential to a main thesis or to the argument in support of that thesis, to distinguish cause-effect relationships from other sequential relationships, and to recognize the point of view of a writer.

   Synthesis is the production of a unique communication, the ability to propose ways of testing hypotheses, the ability to design an experiment, the ability to formulate and modify hypotheses, and the ability to make generalizations.

   Evaluation is defined as making judgments about the value of ideas, solutions, and methods. It involves the use of criteria to appraise the extent to which details are accurate, effective, economical, or satisfying. Evaluation includes the ability to apply given criteria to judgments of work done, to indicate logical fallacies in arguments, and to compare major theories and generalizations.